IES Newsletter

Volume 13, Number 6
November - December 1996

IES invites you ...

... to visit the **Greenhouse**: Helping to warm the winter season are trees ripe with citrus — including the grapefruit-size ponderosa lemons — and papayas; herbs and scented geraniums; and the carnivorous pitcher plant, butterwort and Venus fly-trap (learn *why* they are carnivorous!).

... to sign up for **Continuing Education Program** classes, workshops and excursions: The calendar on the back page of the newsletter lists some of the many January and February offerings.

... to come to free **Sunday Ecology Programs**: Also listed in the calendar, these are for nature enthusiasts of all ages.

... to explore the **IES Ecology Shop**: There are nature and gardening gifts, games and books for adults and children, and plants from the greenhouse in the Plant Room. Remember: IES members receive a discount.

The IES Newsletter is published by the Institute of Ecosystem Studies, located at the Mary Flagler Cary Arboretum in Millbrook, New York.

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The Ecology of Home

by Steward T.A. Pickett

Ever since ecology was established in North America, around one hundred years ago, ecologists have disagreed about whether to include humans and their actions within the scope of their science. Does the ecologist's idea of wilderness have to be an original, untouched landscape, undisturbed by people or natural events? Is it possible to manage wilderness and still have it be wild?

Of course, the direct negative effects of some human activities, such as pollution, have been a proper topic of ecological research. But what about studying the animal and plant communities and ecosystem functions in suburbia, cities, or agricultural regions — places people have lived in, harvested, hunted or otherwise exploited?

Ecologists in North America most often avoided such places and sought out areas distant from people. We ecologists assumed that areas where people were not in evidence were the places where ecological processes were working properly. We assumed that the untoward effects of people on the working of organisms or ecosystems were absent in such "wilderness". Even the photographs ecologists used — still use — to introduce their seminar talks — beautiful mountain peaks, burbling streams, a tall and massive forest casting dense shade — are notable for their absence of people or any evidence of people.

Pervasive Human Activities

Yet the human backdrop is crucial for some ecological research questions. By selectively removing certain tree species or trees of a certain size, humans can affect the composition of the forest community.

Farming activities in the distant past have lasting effects on soil characteristics and thus can affect ecosystem processes in the present time. When people remove natural predators or increase the winter food supply of a particular animal, such as deer, they can affect the population size of that animal.

Even apparently undisturbed areas may be altered by surrounding neighborhoods that are very different from what they once were. For instance, the old-growth South Woods forest at Montgomery Place, here in the Hudson Valley, is bordered by the railroad, the gardens of the estate, mown lawns and meadows, orchards, and a parking lot. This is typical for old forests in the East, but even the larger wilderness areas elsewhere in the country experience fragmentation and assault.

Less visible processes influence wilderness areas as well. Air pollution is one of the most pervasive: microscopic particles bearing toxic metals waft into our high-elevation forests while unprecedented high levels of atmospheric nitrogen pollution fertilize most places in the East.

Moreover, people have removed some of the processes that once contributed to the structure and function of natural systems. For example, in many natural areas in recent decades, natural fires have been deliberately extinguished, fires managed by Native Americans no longer occur, thus changing ecosystems in unexpected ways — for example, prairie patches in the Midwest and East have converted into forest. Or water projects on rivers, by reducing the volume and frequency of floods and changing the times when peak

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MOLLY AHEARN

Dr. Steward Pickett, IES ecologist, at the Tea House overlook. Behind him, the Institute's home: the fields and forests of the Mary Flagler Cary Arboretum.

What Regulates Bacteria in Ecosystems?

Ultimately, bacteria are the "bio" of "biodegradation": with fungi, they are an ecosystem's decomposers and recyclers, breaking down the carbon-containing molecules in the waste products and dead bodies of plants and animals. The resulting nutrients are absorbed through their own cell walls as well as through those of other microorganisms and of plant roots.

Because bacteria play such a critical role in the functioning of ecosystems, ecologists need to know all they can about them. Now, thanks to new analytical techniques developed by IES postdoctoral associate Dr. Paul del Giorgio, the role played by these minute single-celled creatures will become less of a mystery. Dr. del Giorgio, working at IES and the Université du Québec à Montréal in Canada has developed a way to count and measure bacteria using flow cytometry. This technique enables scientists to enumerate bacteria much more rapidly than they can with a microscope, which is the traditional method. Thus, more samples can be analyzed and more information gathered.

Until recently, flow cytometers have had only medical applications, measuring the optical properties of individual cells for research in immunology and molecular biology. While the equipment is complicated, its modus operandi is relatively simple: a laser beam passes through a narrow stream of cells flowing through a chamber. The way the cells scatter the laser light gives information about them. Dr. del Giorgio has found that the flow cytometer can be used very effectively to measure the optical properties of bacteria as well, detailing their number, size and certain morphological properties.

Dr. del Giorgio currently is working on two major projects in which he collaborates in various ways with IES scientists Drs. Jonathan Cole, Michael Pace and Nina Caraco. First, taking advantage of the excellent libraries at Montreal's three universities, he is doing a review of the literature on bacterial growth efficiencies in freshwater and marine systems. Then, at IES, he is applying the techniques he has developed in flow cytometry to a study of bacterial ecology.

How does the growth efficiency of bacteria change across aquatic systems?

There are bacteria in every aquatic system in the world. All consume organic matter, but in some systems — lakes, estuaries and the ocean — they use organic matter more efficiently than in other systems. How efficiently bacteria convert carbon to biomass is an important issue in ecology because many models of aquatic ecosystems incorporate bacteria and assume a high degree of efficiency. Data suggest, however, that bacteria are not as efficient as they were assumed to be. In order to understand accurately the workings of aquatic ecosystems, bacterial efficiency must be quantified.

Starting with data gathered and recorded in the 1940s, when researchers first started thinking about bacterial processes in nature, and finishing with the most recent scientific publications, Dr. del Giorgio has done a comprehensive literature review of all that is known about the factors affecting bacterial efficiency. He and Dr. Cole, together with McGill University doctoral student André Cimbleris, have written a paper — just accepted for publication in *Nature* — summarizing some of the findings, and over the coming year Dr. del Giorgio will write a complete review which will appear in *Annual Review of Ecology and Systematics.*

What are the effects of grazing on the structure of bacterial communities?

Microorganisms graze on bacteria, and therefore are capable of modifying a bacterial community. Flagellates are major consumers, as are ciliated protozoans, such as *Paramecium*, and multicelled creatures like *Daphnia*, minute crustaceans that are commonly called water fleas. Because of the size and structure differences of these predators they don't feed in the same way or on the same types of bacteria, so they don't have the same effects on the community.

Dr. del Giorgio and his IES collaborators are doing experiments in the laboratory and in the field to learn how different grazing behavior affects the internal structure of bacterial communities. In the first part of the study, the scientists are adding flagellates and *Daphnia* to containers of lake water with natural populations of bacteria. To other containers, as experimental controls, they are adding copepods, tiny crustaceans that are for the most part incapable of eating bacteria, to see if the mere presence of animals has any effect. They remove samples at intervals, and Dr. del Giorgio will use flow cytometry to follow changes in the bacterial numbers, size and activity. In the second part of the study, the collaborators will take samples from lakes selected because they have a predominant type of grazer, and, again using flow cytometry, Dr. del Giorgio will see if the data on those bacterial communities agree with the experimental results.

Dr. del Giorgio's library research and hands-on research have the same goal: to learn more about what regulates bacteria in aquatic environments. While individually a bacterium may be an ecosystem's smallest living component, together they are critical to the system's survival. The new knowledge created by Dr. del Giorgio and his IES colleagues will be a significant contribution to an understanding of their role.

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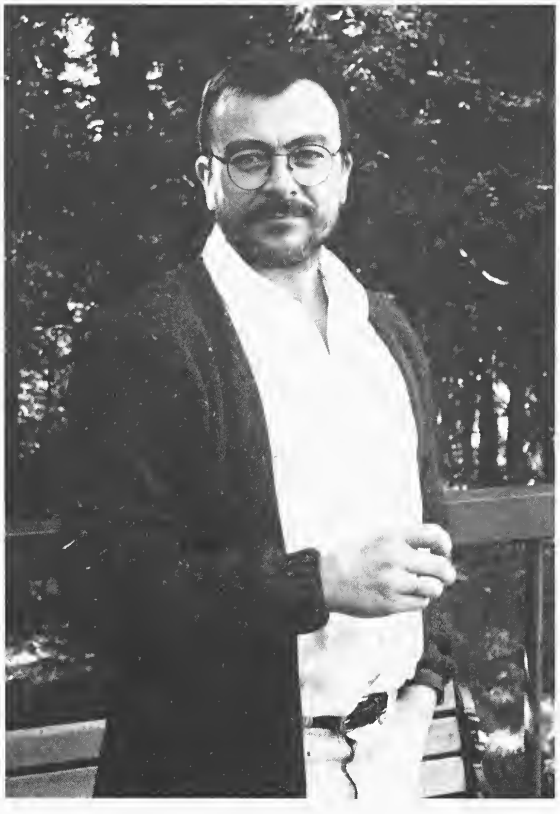
After completing his undergraduate studies at the University of Buenos Aires in Argentina, Dr. Paul del Giorgio (below) moved to Montreal. He received his doctoral degree from McGill University, and did post-doctoral research at the Université du Québec à Montréal. It was then that he became an expert in flow cytometry.

Dr. del Giorgio began his postdoctoral position at the Institute in September 1995; his research is funded by the National Science and Engineering Research Council of Canada. He recently has accepted a position as assistant professor at the Horn Point Environmental Laboratory, part of the University of Maryland, and will begin work there in May 1997.



MOLLY AHEARN

White-Tailed Deer and the Magic of Microbes

by Derek Van De Water

A silver harvest moon gleams over the hills of the Mary Flagler Cary Arboretum. Shadows move in a cluster of chestnut oak trees. On such a crisp autumn night, clouds of steam rise from the spectral figures. They stop momentarily to check the wind, and silently return to feeding. White-tailed deer are grazing on acorns, which are abundant this year under the chestnut oaks. The animals need the high fat content of acorns, because long hard winter months draw near.

Odocoileus virginianus, the white-tailed deer, lives throughout much of North America. This very adaptable herbivore was seen rarely during the early part of the 20th century. Massive lumbering operations, especially in the Northeast, during the late 19th century destroyed much of the deers' habitat. Harsh winters in the 1880s and 1890s contributed to the depletion of the deer herds, as did unlimited hunting. Fearing the imminent extinction of the white-tailed deer, legislators passed laws to curb hunting. At about the same time, devastated clear-cut lands began to regrow, providing excellent feeding habitat. These conditions, along with restocking by environmental agencies, led to a remarkable comeback of the deer population in the 1930s.

For survival, these animals rely on their efficient digestive system, and, of course, on good feeding grounds. Depending on food availability, white-tailed deer are both grazers and browsers. As grazers they feed on grasses, sedges, fruits, nuts, corn, mushrooms and other non-woody plants, while as browsers they feed on the tender shoots, twigs and leaves of trees and shrubs. The deer at the Mary Flagler Cary Arboretum feed both in grassy fields and in woods ripe with acorn-producing oak trees. For reasons not yet understood, in some years oaks produce exceptionally large crops of acorns; these are called mast years. Different species of oak trees have different mast years — 1994 was a mast year for red oaks, for example, while 1996 has been a mast year for chestnut oaks. Deer enjoy the bounty during the fall, but with the onset of winter such food may not be available; this is when they become browsers.

White-tailed deer — like giraffes, antelope, cattle, goats and sheep — are ruminants, with a four-chambered stomach. The first and largest chamber is the rumen, where food accumulates until it is regurgitated, rechewed and then reswallowed. The rumen functions in part as a storage area: deer can fill it quickly, barely chewing what they graze or browse until they reach a safe hiding place to "ruminate" — to chew their cud — at leisure. While food is in the rumen, resident bacteria and protozoa begin to break down cellulose, the material that forms the cell wall of plants. The microbes in the rumen, together with those in the second chamber, the reticulum, ferment carbohydrates from the plant material. The resulting compounds, called volatile fatty acids, are a major source of energy for ruminants. When the food passes into the third chamber, water and minerals are absorbed, and digestive enzymes in the fourth chamber complete the breakdown process. The intestines absorb the nutrients that are left, and any undigestible material is excreted as pellets.

It is the bacteria and protozoa that determine how much nutrition deer get from the plants they eat. Bacteria — as many as 50 billion per gram of rumen-reticulum contents (a gram is slightly less than one-twentififth of an ounce) — and protozoa, in fewer numbers but roughly equivalent mass, are always present, but their composition is not always the same. Over two or three weeks each spring and fall, as the type of available food changes, the types of microorganisms in the rumen and reticulum change. During this changeover, digestion is not efficient and although the animals are eating they are receiving very little nutrition.

Well-meaning landowners or sportsmen who want to help deer survive the winter would be wise to educate themselves about the nutritional habits and requirements of these animals. Providing supplemental food in the form of browse is ideal, as this is the material the deer's digestive tracts are prepared for. If using feed such as hay or corn, however, benefactors should start before the stressful conditions begin and continue through the early signs of spring green.

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Derek Van De Water became interested in writing for the IES NEWSLETTER while completing requirements for a bachelor's degree in communications at Fredonia State College in Fredonia, N.Y. Now, in addition to working toward a master's degree at Marist College in Poughkeepsie, N.Y., he is a volunteer with the Institute's Education Program.

Home, *from page 1*

flows occur, have changed the wetlands and even the forest ecosystems in the rivers' floodplains.

Scrutinizing the Backyard

Because we ecologists have assumed we were to study wilderness, we have missed factoring in many such human effects. But for ecologists to attempt to confine themselves to "pristine" areas when humans' effects on the environment are so widespread and so large will leave much of the globe beyond ecological understanding. Rather than seeing the world as divided in two — the natural and the human, wilderness and non-wilderness, the pristine and the ruined — our proper field of study is the complex of the two. Now most ecosystems have a natural component and a human component; now most disturbances can be attributed to both natural processes and human events. The world is both wild and civilized.

Ecologists must seek to understand to what extent human actions mimic, exceed, or counteract the natural variation that has contributed to the structure of ecological systems over time. And for research into many systems or where the goal is to help society evaluate environmental policy, the human influences must be confronted head-on and studied directly.

The human influences must also be factored into our management and use of nature. If we could divide the world into wilderness and non-wilderness, then we could let wilderness take care of itself — the natural world has been running along on its own for hundreds of millions of years.

But the reality is that virtually all ecosystems have been altered and many replaced as a result of human activities. A wider recognition of this should enable ecologists and managers to work to discover ways to replace ecosystem functions. For example, managers might remove non-native species that are favored by high levels of nitrogen pollution, reintroduce fire as a management tool, and restore appropriate flooding regimes to river ecosystems.

In the book Uncommon Ground (W.W. Norton Co., 1995), environmental historian William Cronon reminds us that when deciding how to plan land use and manage our lands, we're better off thinking of our environment simply as "home". Somehow, ecologists, and lay people as well, need to figure out how to overcome the division into separate categories so that we understand all of the living world and can help to keep our household in good working order.

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Newsletter

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Calendar

CONTINUING EDUCATION

For **Winter/Spring 1997** catalogues and program information, call the Continuing Education office at 914/677-9643. Upcoming programs include:

Landscape Design

Jan. 15 (7 ses.): **Landscape Design Graphics**
Jan. 23 (3 ses.): **Marketing and Estimating Landscape and Gardening Services**
Jan. 28 (6 ses.): **Principles of Landscape Design**
Feb. 22: **Residential Landscape Design Clinic**

Gardening

Jan. 25: **Gardening on a Damp Site**
Jan. 25: **Understanding Botanical Names**
Feb. 1: **Tree Care**
Feb. 8: **Ornamental Grasses in the Garden**
Feb. 22: **Native Trees and Shrubs**
Feb. 22: **Topiaries, Standards and Beyond**
Feb. 23: **Establishing a Wildflower Meadow**

Excursions and Tours

Feb. 9: **"Order and Chaos: Patterns of the Natural World and Changes in Our Land", at the Bruce Museum**

Workshops

Mar. 1: **Opportunities in Garden Writing** (co-sponsor: Garden Writers Association of America)

SUNDAY ECOLOGY PROGRAMS

Free public programs are held once a month, usually on the first Sunday. Call 914/677-5359 to confirm the day's topic or, in case of poor weather, to learn the status of the day's program.
Jan. 5: **Grand Canyon: A Window in Time**, a slide presentation by Dr. Alan Berkowitz, IES head of education and former naturalist at the Grand Canyon. *2 p.m. at the IES Auditorium.*
Feb. 2: **Plant Power**, an activity led by IES educator Kris Desmarais. *2 p.m. at the IES Greenhouse on Route 82.*

VOLUNTEER OPPORTUNITIES

Volunteers are needed to help in the Continuing Education Program office. Experience with dBASE would be especially useful; a comfortable relationship with computers is absolutely necessary. For information on responsibilities and benefits, and on other volunteer opportunities, call Ms. Su Marcy at 914/677-5359.

IES SEMINARS

Free scientific seminars are held each Friday at 3:30 p.m. at the IES Auditorium:
Jan. 18: To be announced
Jan. 24: **The Ecology of Rotting Birch Leaves.** Dr. Mitch Wagener, Western Conn. State Univ., Danbury.
Jan. 31: To be announced
Feb. 7: Topic: **Bacteria and DOC.** Dr. Lars Tranvik, Univ. of Lund, Sweden.
Feb. 14: To be announced
Feb. 21: Title to be announced. Dr. Jennifer Tank, Virginia Tech.
Feb. 28: Seminar by IES Visiting Distinguished Scientist Dr. Mary K. Firestone, Dept. of Environmental Science Policy and Management, Univ. of Calif. at Berkeley.
Mar. 7: Topic: **Dissolved organic carbon and nitrogen.** Dr. William McDowell, Univ. of New Hampshire.

GREENHOUSE

The IES greenhouse, a year-round tropical plant paradise and a site for controlled environmental research, is open until 3:30 p.m. daily except public holidays. Admission is by free permit (see "HOURS").

HOURS

Winter hours: October 1 - April 30
Closed on public holidays.

Public attractions are open Mon. - Sat., 9 a.m.-4 p.m. & Sun. 1-4 p.m., with a free permit*.
The **IES Ecology Shop** is open Mon.- Fri., 11a.m.-4 p.m., Sat. 9 a.m.-4 p.m. & Sun. 1-4 p.m. (The shop is closed weekdays from 1-1:30 p.m.)

Holiday Hours: The IES Ecology Shop will close at 3 p.m. on December 24 and 31.

* *Free permits are required for visitors and are available at the IES Ecology Shop or the Education Program office daily until 3 p.m.*

IES ECOLOGY SHOP

New in the Shop ... long-sleeved Jim Morris T-shirts ... bird feeders ... gardening journals ... music and nature cassettes ... **for children** ... nature activity books and card games ... **and in the Plant Room** ... indoor & outdoor garden tools
January: Discounts on all merchandise; holiday gifts and plants half-price
February 1-14: Valentine's Day specials
Senior Citizens Days: 10% off on Wednesdays
•• **Gift Certificates** are available ••

MEMBERSHIP

Join the Institute of Ecosystem Studies. Benefits include a member's rate for courses & excursions, a 10% discount on IES Ecology Shop purchases, a free subscription to the newsletter and participation in a reciprocal admissions program. Individual membership: $30; family membership: $40. Call Ms. Janice Claiborne at 914/677-5343.

The Institute's Aldo Leopold Society
In addition to receiving the benefits listed above, members of The Aldo Leopold Society are invited guests at spring and fall IES science updates. Call Ms. Jan Mittan at 914/677-5343.

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